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इलैक्ट्रॉनी उपस्करों में प्रयुक्त जड़ित संधारित्र

भाग 15 सेक्शनल विशिष्टि:
नम्य अथवा ठोस विद्युत-अपघट्य सहित जड़ित टैंटलम संधारित्र

Indian Standard

FIXED CAPACITORS FOR USE IN ELECTRONIC EQUIPMENT

PART 15 SECTIONAL SPECIFICATION: FIXED TANTALUM CAPACITORS WITH NON-SOLID OR SOLID ELECTROLYTE

ICS 31.060.40

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MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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Price Group 11

Resistors and Capacitors for Electronic Equipment Sectional Committee, LTD 14

NATIONAL FOREWORD

This Indian Standard which is identical with IEC 384-15/IEC QC 300200 (1982) 'Fixed capacitors for use in electronic equipment — Part 15: Sectional specification: Fixed tantalum capacitors with non-solid or solid electrolyte' [along with Amendment No. 1 and 2 (1982)] issued by the International Electrotechnical Commission (IEC) was adopted by the Bureau of Indian Standards on the recommendation of Resistors and Capacitors for Electronic Equipment Sectional Committee and approval of the Electronics and Telecommunication Division Council.

The text of the IEC standard has been approved as suitable for publication as Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appear referring to this Standard, they should be read as 'Indian Standard'.

b) Comma (,) has been used as a decimal marker while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

Amendment No. 1 (1987) and Amendment No. 2 (1992) to the above International Standard have been printed at the end.

Only the English language text in the International Standard has been retained while adopting it in this standard.

This standard is intended primarily for use under IECQ system.

CROSS REFERENCES

In this adopted standard, reference appears to certain Internationl Standards for which Indian Standards also exist. The corresponding Indian Standards which are to be substituted in their place are listed below along with their degree of equivalence for the editions indicated:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC 62 (1974) Marking codes for resistors and capacitors	IS 8186 : 1976 Marking codes for values and tolerance of resistors and capacitors	Technically equivalent
IEC 63 (1963) Preferred number series for resistors and capacitors	IS 824 : 1965 Preferred values for resistors and capacitors	do
IEC 68 (1978) Basic environmental testing procedures	IS 9000 (Part 1) : 1988 Basic environmental testing procedures for electronic and electrical items : Part 1 General	do
IEC 384-1 (1982) Fixed capacitors for use in electronic equipment — Part 1: Generic specification	IS QC 300000 : 1988/ IEC QC 300000 : 1982 Fixed capacitors for use in electronic equipment: Generic specification	Identical
IEC 410 (1973) Sampling plan and procedures for inspection by attributes	IS 10673 : 1983 Sampling plans and procedures for inspection by attributes for electronic items	Not equivalent
IEC QC 001001 (1986) Basic rules of the IEC qualiy assessment system for electronic components (IECQ)	IS QC 001001 : 1988/IEC QC 001001 : 1986 Basic rules of the IEC quality assessment system for electronic components (IECQ)	Identical

(Continued on third cover)

Indian Standard
FIXED CAPACITORS FOR USE IN ELECTRONIC EQUIPMENT

PART 15 SECTIONAL SPECIFICATION: FIXED TANTALUM CAPACITORS WITH NON-SOLID OR SOLID ELECTROLYTE

1. General

1.1 *Scope*

This standard applies to polar and bipolar tantalum electrolyte capacitors with solid and non-solid electrolyte for use in electronic equipment.

It comprises capacitors for long-life applications and capacitors for general-purpose applications. Capacitors for special purpose application may need additional requirements.

This standard covers three basic sub-families, namely:

Sub-family 1: Fixed non-solid electrolyte tantalum capacitors with foil electrode.

1A: Plain foil electrode.
1B: Etched foil electrode.

Sub-family 2: Fixed non-solid electrolyte tantalum capacitors with porous anode.

Sub-family 3: Fixed solid electrolyte tantalum capacitors with porous anode.

1.2 *Object*

The object of this standard is to prescribe preferred ratings and characteristics and to select from I E C Publication 384-1 (1982), the appropriate quality assessment procedures, tests and measuring methods and to give general performance requirements for this type of capacitor. Test severities and requirements prescribed in detail specifications referring to this sectional specification shall be of equal or higher performance level, because lower performance levels are not permitted.

1.3 *Related documents*

I E C publications:

Publication 62 (1974): Marking Codes for Resistors and Capacitors.

Publication 63 (1963): Preferred Number Series for Resistors and Capacitors.
Amendment No. 1 (1967).
Amendment No. 2 (1977).

Publication 68:	Basic Environmental Testing Procedures.
Publication 384-1 (1982):	Fixed Capacitors for Use in Electronic Equipment. Part 1: Generic Specification.
Publication 410 (1973):	Sampling Plans and Procedures for Inspection by Attributes.
Publication QC 001001: (1981)	Basic Rules of the I E C Quality Assessment System for Electronic Components (IECQ).
Publication QC 001002: (1981)	Rules of Procedure of the I E C Quality Assessment System for Electronic Components (IECQ).

ISO Publication:

ISO Standard 3:	Preferred Numbers — Series of Preferred Numbers.

Note. — The above references apply to the current editions except for I E C Publication 68, for which the referenced edition in the applicable test clauses of the generic specification shall be used.

1.4 *Information to be given in a detail specification*

Detail specifications shall be derived from the relevant blank detail specification.

Detail specifications shall not specify requirements inferior to those of the generic, sectional or blank detail specification. When more severe requirements are included, they shall be listed in Sub-clause 1.9 of the detail specification and indicated in the test schedules, for example by an asterisk.

Note. — The information given in Sub-clause 1.4.1 may for convenience, be presented in tabular form.

The following information shall be given in each detail specification and the values quoted shall preferably be selected from those given in the appropriate clause of this sectional specification.

1.4.1 *Outline drawing and dimensions*

There shall be an illustration of the capacitor as an aid to easy recognition and for comparison of the capacitor with others. Dimensions and their associated tolerances, which affect interchangeability and mounting, shall be given in the detail specification. All dimensions shall preferably be stated in millimetres, however when the original dimensions are given in inches, the converted metric dimensions in millimetres shall be added.

Normally the numerical values shall be given for the length of the body, the width and height of the body and the wire spacing, or for cylindrical types, the body diameter, and the length and diameter of the terminations. When necessary, for example when a number of items (capacitance values/voltage ranges) are covered by a detail specification, the dimensions and their associated tolerances shall be placed in a table below the drawing.

When the configuration is other than described above, the detail specification shall state such dimensional information as will adequately describe the capacitor. When the capacitor is not designed for use on printed boards, this shall be clearly stated in the detail specification.

1.4.2 *Mounting*

The detail specification shall specify the method of mounting to be applied for normal use and for the application of the vibration and the bump or shock tests. The capacitors shall be mounted by their normal means. The design of the capacitor may be such that special mounting fixtures are required in its use. In this case, the detail specification shall describe the mounting fixtures and they shall be used in the application of the vibration and bump or shock tests.

1.4.3 *Rating and characteristics*

The ratings and characteristics shall be in accordance with the relevant clauses of this specification, together with the following:

1.4.3.1 *Rated capacitance range*

See Sub-clause 2.2.1.

Note. — When products approved to the detail specification may have different ranges, the following statement should be added:
"The range of values available in each voltage range is given in the qualified products list."

1.4.3.2 *Particular characteristics*

Additional characteristics may be listed, when they are considered necessary to specify adequately the component for design and application purposes.

1.4.3.3 *Soldering*

The detail specification shall prescribe the test methods, severities and requirements applicable for the solderability test and the resistance to soldering heat test.

1.4.4 *Marking*

The detail specification shall specify the content of the marking on the capacitor and on the package. Deviations from Sub-clause 1.6 of this sectional specification, shall be specifically stated.

1.5 *Terminology*

In addition to the applicable terms and definitions of I E C Publication 384-1 the following definitions apply:

1.5.1 *Capacitance of an electrolytic capacitor*

The capacitance of an equivalent circuit having capacitance and resistance in series measured with alternating current of approximately sinusoidal waveform of the specified frequency.

1.5.2 *Long-life grade capacitors*

Capacitors intended for applications where a high degree of stability of characteristics over a long life is essential.

The materials are so chosen and manufacture so carried out that improved performance is obtained with consequent increase in life.

1.5.3 *General-purpose grade capacitors*

Capacitors intended for applications where the high performance level of long-life grade capacitors is not required.

1.5.4 *Rated voltage* (U_R)

The maximum direct voltage which may be applied continuously to the terminations of a capacitor at the rated temperature.

Note 1. — The sum of the direct voltage and the peak alternating voltage applied to the capacitor shall not exceed the rated voltage.

2. — For short periods, however, the rated voltage may be exceeded (see Sub-clauses 2.2.6 and 4.13).

1.6 *Marking*

According to Sub-clause 2.4 of IEC Publication 384-1, with the following details:

1.6.1 The information given in the marking is normally selected from the following list; the relative importance of each item is indicated by its position in the list:

a) rated capacitance;

b) rated voltage (d.c. voltage may be indicated by the symbol ═══ or ——);

c) category voltage and category temperatures (for long-life grade capacitors only) (if applicable);

d) polarity of the terminations:
polar capacitors shall be marked with a positive sign near the positive terminations.
Bipolar capacitors shall be marked positive at both ends and, if space permits, in addition with the letters "BP";

e) tolerance on rated capacitance;

f) reference to the grade. (For long-life grade capacitors only).
The abbreviation "LL" may be used for marking purposes;

g) year and month (or week) of manufacture;

h) manufacturer's name or trade mark;

i) indication of the sub-family (e.g. 1, 2 or 3);

j) climatic category;

k) manufacturer's type designation;

l) reference to the detail specification.

1.6.2 The capacitor shall be clearly marked with *a)*, *b)* and *d)* above and with as many as possible of the remaining items as is considered necessary. Any duplication of information in the marking on the capacitor should be avoided.

1.6.3 The package containing the capacitor(s) shall be clearly marked with all the information listed in Sub-clause 1.6.1.

1.6.4 Any additional marking shall be so applied that no confusion can arise.

SECTION TWO — PREFERRED RATINGS AND CHARACTERISTICS

2. **Preferred ratings and characteristics**

2.1 *Preferred characteristics*

The values given in detail specifications shall preferably be selected from the following:

2.1.1 *Preferred climatic categories*

The capacitors covered by this specification are classified into climatic categories according to the general rules given in IEC Publication 68-1.

The lower and upper category temperature and the duration of the damp heat, steady state test shall be chosen from the following:

Lower category temperature:	−55 °C.
Upper category temperature:	+85 °C, +100 °C and +125 °C.
Duration of the damp heat, steady state test:	4, 10, 21 and 56 days.

The severities for the cold and dry heat tests are the lower and upper category temperatures respectively.

2.2 *Preferred values of ratings*

2.2.1 *Rated capacitance* (C_R)

Preferred values of rated capacitance are chosen from the E3 series of IEC Publication 63 and their decimal multiples. If other values are needed, they shall preferably be chosen from the E6 series.

2.2.2 *Tolerance on rated capacitance*

Preferred values of tolerances on rated capacitance are:

Solid electrolyte capacitors	Non-solid electrolyte capacitors
± 5 % ± 10 % ± 20 %	± 10 % ± 20 % −10/+30 % −10/+50 %

2.2.3 *Rated voltage* (U_R)

Preferred values of rated direct voltages taken from the R5 series of ISO Standard 3 are:

1.0 — 1.6 — 2.5 — 4.0 — 6.3 and their decimal multiples.

If other values are required they shall preferably be chosen from the R10 series.

2.2.4 *Category voltage* (U_C)

The category voltage is equal to the rated voltage, unless otherwise stated in the detail specification.

2.2.5 *Reverse voltage*

The permissible reverse voltage shall be given in the detail specification.

2.2.6 *Surge voltage*

The surge voltage shall be 1.15 times the rated or category voltage rounded off to the nearest volt.

2.2.7 *Ripple* (if applicable)

Ripple current and/or ripple voltage shall be specified in the detail specification.

2.2.8 *Rated temperature*

The value of the rated temperature is 85 °C unless otherwise stated in the detail specification.

SECTION THREE — QUALITY ASSESSMENT PROCEDURES

3. Quality assessment procedures

3.1 *Primary Stage of Manufacture*

The primary stage of manufacture is the forming of the oxide.

3.2 *Structurally Similar Components*

Capacitors considered as being structurally similar are capacitors produced with similar processes and materials, though they may be of different case sizes and values.

3.3 *Certified Records of Released Lots*

The information required in Sub-clause 3.5.1 of IEC Publication 384-1 shall be made available when prescribed in the detail specification and when requested by a purchaser. After the endurance test, the parameters for which variables information is required are the capacitance change, tan δ and the leakage current.

3.4 *Qualification Approval*

The procedures for Qualification Approval testing are given in Sub-clause 3.4 of the Generic Specification, I E C Publication 384-1.

The schedule to be used for Qualification Approval testing on the basis of lot-by-lot and periodic tests is given in Sub-clause 3.5 of this specification. The procedure using a fixed sample size schedule is given in Sub-clauses 3.4.1 and 3.4.2 below.

3.4.1 *Qualification Approval on the basis of the fixed sample size procedures*

Sampling

The fixed sample size procedure is described in I E C Publication 384-1, Sub-clause 3.4.2 *b)*. The sample shall be representative of the range of capacitors for which approval is sought. This may or may not be the complete range covered by the detail specification.

The sample shall consist of specimens having the lowest and highest voltages, and for these voltages the smallest and largest case size. When there are more than four case sizes an intermediate case size shall also be tested. In each of these case size/voltage combinations (values) the highest capacitance shall be chosen. Thus for the approval of a range, testing is required of either four or six values. When the range consists of less than four values, the number of specimens to be tested shall be that required for four values.

Spare specimens are permitted as follows:

a) One per value which may be used to replace the permitted defective in Group "0".

b) One per value which may be used as replacements for specimens which are defective because of incidents not attributable to the manufacturer.

The numbers given in Group "0" assume that all groups are applicable. If this is not so the numbers may be reduced accordingly.

When additional groups are introduced into the Qualification Approval test schedule, the number of specimens required for Group "0" shall be increased by the same number as that required for the additional groups.

Table I gives the number of samples to be tested in each group or sub-group together with the permissible number of defectives for qualification approval tests.

3.4.2 *Tests*

The complete series of tests specified in Tables I and II are required for the approval of capacitors covered by one detail specification. The tests of each group shall be carried out in the order given.

The whole sample shall be subjected to the tests of Group "0" and then divided for the other groups.

Specimens found defective during the tests of Group "0" shall not be used for the other groups.

"One defective" is counted when a capacitor has not satisfied the whole or a part of the tests of a group.

The approval is granted when the number of defectives does not exceed the specified number of permissible defectives for each group or sub-group and the total number of permissible defectives.

Note. — Tables I and II together form the fixed sample size test schedule, for which Table I includes the details for the sampling and permissible defectives for the different tests or groups of tests, whereas Table II together with the details of test contained in Section Four gives a complete summary of test conditions and performance requirements and indicates where e.g. for the test method or conditions of test a choice has to be made in the detail specification.

The conditions of test and performance requirements for the fixed sample size test schedule shall be identical to those prescribed in the detail specification for quality conformance inspection.

TABLE I

Sampling plan together with numbers of permissible defectives for qualification approval tests

Group No.	Test	Sub-clause of this publication	Number of specimens (*n*) and number of permissible defectives (*pd*)						
			Per value[4]	For four or less values[4] to be tested			For six values[4] to be tested		
			n	4*n*	*pd*	*pd* total	6*n*	*pd*	*pd* total
0	Visual examination Dimensions Leakage current Capacitance Tangent of loss angle Impedance[1]	4.1 4.1 4.2.1 4.2.2 4.2.3 4.2.4	26	104	1		156	2[2]	
	Spare specimens		2	8			12		
1A	Robustness of terminations Resistance to soldering heat	4.3 4.4	3	12	1	4	18	1	6
1B	Solderability Rapid change of temperature Vibration Bump or shock[3]	4.5 4.6 4.7 4.8 or 4.9	6	24	1		36	2[2]	
1	Climatic sequence	4.10	9	36	2[2]		54	2[2]	
2	Damp heat, steady state	4.11	5	20	1		30	2[2]	
3	Endurance	4.12	5	20	1		30	2[2]	
4A	Surge voltage	4.13	2	8	1		12	1	
4B	Reverse voltage[1]	4.14	2	8			12	1	
5	Characteristics at high and low temperature Charge and discharge[1]	4.15 4.16	3	12	1		18	2[2]	

[1] If prescribed in the detail specification.

[2] Not more than one defective is permitted from any one value.

[3] As prescribed in the detail specification.

[4] Case size/voltage combinations, see Sub-clause 3.4.1.

TABLE II

Test schedule for Qualification Approval

Notes 1. — Sub-clause numbers in this schedule refer to Section Four: Test and measurement procedures.

2. — In this table: D = destructive, ND = non-destructive.

Sub-clause number and Test (see Note 1)	D or ND	Conditions of test (see Note 1)	Number of specimens (n) and number of permissible defectives (pd)	Performance requirements (see Note 1)
Group 0	ND		See Table I	
4.1 Visual examination				As in 4.1 Legible marking and as specified in the detail specification
4.1 Dimensions (detail)				See detail specification
4.2.1 Leakage current		Protective resistance: ... Ω		See detail specification
4.2.2 Capacitance		Frequency: ... Hz		Within specified tolerance
4.2.3 Tangent of loss angle (tan δ)		Frequency: ... Hz		See detail specification
4.2.4 Impedance (if applicable)		Frequency: ... kHz		See detail specification
Group 1A	D		See Table I	
4.3.1 Initial measurement		Capacitance		
4.3 Robustness of terminations		Visual examination		No visible damage
4.4 Resistance to soldering heat		No pre-drying See detail specification for the method (1A or 1B)		
4.4.2 Final measurements		Visual examination		No visible damage and for non-solid electrolyte capacitors, no leakage of electrolyte Legible marking
Group 1B	D		See Table I	
4.5 Solderability		Without ageing See detail specification for the method		Good tinning as evidenced by free flowing of the solder with wetting of the terminations or solder shall flow within ... s, as applicable
4.6.1 Initial measurement		Capacitance		
4.6 Rapid change of temperature		θ_A = Lower category temperature θ_B = Upper category temperature Five cycles Duration t = 30 min Recovery: 16 h		

(Table continued on page 10)

TABLE II *(continued)*

Sub-clause number and Test (see Note 1)	D or ND	Conditions of test (see Note 1)	Number of specimens (*n*) and number of permissible defectives (*pd*)	Performance requirements (see Note 1)
Group 1B (continued)			See Table I	
4.6.3 Final measurements		Leakage current		See detail specification
		Capacitance		See detail specification
		Tangent of loss angle		See detail specification
4.7 Vibration		For mounting method see detail specification Procedure B4 Frequency range: from ... Hz to ... Hz Amplitude: ... mm or acceleration ... m/s² (whichever is the less severe) Duration: ... h		
4.7.2 Final inspection		Visual examination		No visible damage and for non-solid electrolyte capacitors no leakage of electrolyte
4.8 Bump (or shock, see 4.9)		For mounting method see detail specification Number of bumps: ... Acceleration: 390 m/s² Duration of pulse: 6 ms		
4.9 Shock (or bump, see 4.8)		For mounting method see detail specification Acceleration: ... m/s² Duration of pulse: ... ms		
4.8.2 or 4.9.2 Final measurements		Visual examination		No visible damage and for non-solid electrolyte capacitors no leakage of electrolyte
Group 1	D		See Table I	
4.10 Climatic sequence				
4.10.1 Initial measurement		Capacitance		
4.10.2 Dry heat		Temperature: upper category temperature Duration: 16 h Visual examination		No visible damage and for non-solid electrolyte capacitors no leakage of electrolyte
4.10.3 Damp heat, cyclic, Test Db, first cycle				

(Table continued on page 11)

TABLE II *(continued)*

Sub-clause number and Test (see Note 1)	D or ND	Conditions of test (see Note 1)	Number of specimens (*n*) and number of permissible defectives (*pd*)	Performance requirements (see Note 1)
Group 1 (continued)			See Table I ↓	
4.10.4 Cold		Temperature: lower category temperature Duration: 2 h		
		Visual examination		No visible damage and for non-solid electrolyte capacitors no leakage of electrolyte
4.10.5 Low air pressure (if required by the detail specification)		Air pressure: 8.5 kPa (85 mbar)		
		Visual examination		No breakdown, flashover or harmful deformation of the case
4.10.6 Damp heat, cyclic, Test Db, remaining cycles				
4.10.7 Sealing (if required by the detail specification)		**Method:** ...		
4.10.8 Final measurements		**Visual examination**		No visible damage and for non-solid electrolyte capacitors no leakage of electrolyte Legible marking
		Leakage current		≤ initial limit
		Capacitance		$\frac{\Delta C}{C}$ for: *Long-life grade:* ≤ 5% of value measured in 4.10.1 and ≤ 8% of value measured in 4.3.1 or 4.6.1 as applicable *General-purpose grade:* ≤ 12% of value measured in 4.10.1
		Tangent of loss angle		*Sub-family 1:* ≤ 1.15 times initial limit *Sub-families 2 and 3:* ≤ initial limit
Group 2	D		See Table I ↓	
4.11 Damp heat, steady state				
4.11.1 Initial measurement		Capacitance		

(Table continued on page 12)

TABLE II *(continued)*

<table>
<tr><th>Sub-clause number and Test (see Note 1)</th><th>D or ND</th><th>Conditions of test (see Note 1)</th><th>Number of specimens (n) and number of permissible defectives (pd)</th><th>Performance requirements (see Note 1)</th></tr>
<tr><td>Group 2 (continued)</td><td></td><td></td><td>See Table I</td><td></td></tr>
<tr><td>4.11.2 Final measurements</td><td></td><td>Visual examination</td><td></td><td>No visible damage and for non-solid electrolyte capacitors no leakage of electrolyte
Legible marking</td></tr>
<tr><td></td><td></td><td>Leakage current</td><td></td><td>≤ initial limit</td></tr>
<tr><td></td><td></td><td>Capacitance</td><td></td><td>$\frac{\Delta C}{C}$ for:
<i>Long-life grade:</i> ≤ 5% of value measured in 4.11.1
<i>General-purpose grade:</i> ≤ 12% of value measured in 4.11.1</td></tr>
<tr><td></td><td></td><td>Tangent of loss angle</td><td></td><td><i>Sub-families 1 and 2:</i> ≤ 1.15 times initial limit
<i>Sub-family 3:</i> ≤ initial limit</td></tr>
<tr><td></td><td></td><td>Insulation resistance of the external insulation (if applicable)</td><td></td><td>≥ 100 MΩ</td></tr>
<tr><td></td><td></td><td>Voltage proof of the external insulation (if applicable)</td><td></td><td>No breakdown or flashover</td></tr>
<tr><td>Group 3</td><td>D</td><td></td><td>See Table I</td><td></td></tr>
<tr><td>4.12 Endurance</td><td></td><td>Duration:
Long-life grade: 2 000 h
General-purpose grade: 1 000 h
Ambient temperature: ... °C (as applicable)
Applied voltage: ... V
Recovery: 16 h</td><td></td><td></td></tr>
<tr><td>4.12.1 Initial measurement</td><td></td><td>Capacitance</td><td></td><td></td></tr>
<tr><td>4.12.3 Final measurements</td><td></td><td>Visual examination</td><td></td><td>No visible damage
Legible marking</td></tr>
<tr><td></td><td></td><td>Leakage current</td><td></td><td>≤ 1.25 times initial limit</td></tr>
<tr><td></td><td></td><td>Capacitance</td><td></td><td>$\frac{\Delta C}{C}$ compared to values measured in 4.12.1:
<table>
<tr><th>Sub-family</th><th>U_R (V)</th><th>85°C</th><th>125°C*</th></tr>
<tr><td>1A</td><td>≤ 160</td><td>≤ 20%</td><td>≤ 25%</td></tr>
<tr><td></td><td>> 160</td><td>≤ 15%</td><td>≤ 20%</td></tr>
<tr><td>1B</td><td>≤ 160</td><td>≤ 15%</td><td>≤ 25%</td></tr>
<tr><td></td><td>> 160</td><td>≤ 10%</td><td>≤ 20%</td></tr>
</table></td></tr>
</table>

* If applicable.

(Table continued on page 13)

TABLE II *(continued)*

Sub-clause number and Test (see Note 1)	D or ND	Conditions of test (see Note 1)	Number of specimens (*n*) and number of permissible defectives (*pd*)	Performance requirements (see Note 1)
Group 3 (continued)			See Table I	*Sub-family 2:* ≤ 20% *Sub-family 3:* ≤ 10%
		Tangent of loss angle		*Sub-families 1 and 2:* ≤ 1.3 times initial limit *Sub-family 3:* ≤ initial limit
Group 4A	D		See Table I	
4.13 Surge		Number of cycles: 1 000 Temperature: ... °C Protective resistor: 1 000 Ω ± 10% Duration of charge: 30 s Duration of discharge: 5 min 30 s		
4.13.1 Initial measurement		Capacitance		
4.13.3 Final measurements		Leakage current		≤ initial limit
		Capacitance		$\frac{\Delta C}{C}$: *Sub-family 1:* ≤ 5% *Sub-families 2 and 3:* ≤ 10% of value measured in 4.13.1
		Tangent of loss angle		*Sub-family 1:* ≤ 1.15 times initial limit *Sub-family 2:* ≤ 1.3 times initial limit *Sub-family 3:* ≤ initial limit
Group 4B	D		See Table I	
4.14 Reverse voltage (if required)		Duration: 125 h at upper category temperature with a voltage of ... V, in reverse polarity direction, followed by 125 h at upper category temperature with category voltage in forward polarity direction		
4.14.1 Initial measurement		Capacitance		
4.14.3 Final measurements		Leakage current		*Sub-families 1 and 2:* ≤ 1.25 times initial limit *Sub-family 3:* ≤ initial limit
		Capacitance		$\frac{\Delta C}{C}$ ≤ 10% of value measured in 4.14.1
		Tangent of loss angle		≤ 1.15 times initial limit

(Table continued on page 14)

TABLE II *(continued)*

Sub-clause number and Test (see Note 1)	D or ND	Conditions of test (see Note 1)	Number of specimens (*n*) and number of permissible defectives (*pd*)	Performance requirements (see Note 1)
Group 5	D		See Table I	
4.15 Characteristics at high and low temperature		The capacitors shall be measured at each temperature step		
		Step 1: 20 °C		
		Leakage current		For use as reference value
		Capacitance		
		Tangent of loss angle		
		Impedance* (at same frequency as Step 2)		
		Step 2: Lower category temperature		
		Capacitance		See detail specification
		Tangent of loss angle*		See detail specification
		Impedance*		See detail specification
		Step 3: Rated temperature		
		Leakage current		See detail specification
		Capacitance		See detail specification
		Tangent of loss angle*		See detail specification
		Impedance*		See detail specification
		Step 4: Upper category temperature		
		Leakage current		See detail specification
		Capacitance		See detail specification
		Tangent of loss angle*		See detail specification
		Impedance*		See detail specification
4.16 Charge and discharge (if required)		Temperature: 20 °C Number of cycles: 10^6 Duration of charge: 0.5 s Charge resistor: ... Ω Duration of discharge: 0.5 s Discharge resistor: ... Ω		
4.16.1 Initial measurement		Capacitance		
4.16.3 Final measurements		Visual examination		No visible damage and for non-solid electrolyte capacitors no leakage of electrolyte

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* If applicable.

(Table continued on page 15)

TABLE II *(continued)*

Sub-clause number and Test (see Note 1)	D or ND	Conditions of test (see Note 1)	Number of specimens (*n*) and number of permissible defectives (*pd*)	Performance requirements (see Note 1)
Group 5 (continued)			See Table I	
		Capacitance	↓	$\frac{\Delta C}{C}$ for: *Sub-families 1 and 2:* $\leqslant$ 10% of value measured in 4.16.1 *Sub-family 3:* $\leqslant$ 5% of value measured in 4.16.1
		Tangent of loss angle	↓	$\leqslant$ initial limit

3.5 *Quality Conformance Inspection*

3.5.1 *Formation of inspection lots*

a) Groups A and B inspection

These tests shall be carried out on a lot-by-lot basis.

A manufacturer may aggregate the current production into inspection lots subject to the following safeguards:

(1) The inspection lot shall consist of structurally similar capacitors (see Sub-clause 3.2).

(2*a*)) The sample tested shall be representative of the values and dimensions contained in the inspection lot:
- in relation to their number;
- with a minimum of five of any one value.

(2*b*)) If there are less than five of any one value in the sample the basis for the drawing of samples shall be agreed between the manufacturer and the National Supervising Inspectorate.

b) Group C inspection

These tests shall be carried out on a periodic basis.

Samples shall be representative of the current production of the specified periods and shall be divided into high, medium and low voltage ratings or case sizes. In order to cover the range of approvals in any period, one high, one medium and one low voltage or case size shall be tested. In subsequent periods other voltages or case sizes in production shall be tested with the aim of covering the whole range.

3.5.2 *Test schedule*

The schedule for the lot-by-lot and periodic tests for Quality Conformance Inspection is given in Section Two, Table IV of the Blank Detail Specification, IEC Publications 384-15-1, 384-15-2 or 384-15-3, as applicable.

3.5.3 *Delayed delivery*

When according to the procedures of IEC Publication 384-1, Sub-clause 3.5.2, re-inspection has to be made, solderability and capacitance shall be checked as specified in Group A and B inspection.

3.5.4 *Assessment levels*

The assessment level(s) given in the blank detail specification shall preferably be selected from Tables III A and III B:

TABLE III A

Inspection sub-group**	D*		E		F*		G*	
	IL	AQL (%)	IL	AQL (%)	IL	AQL (%)	IL	AQL (%)
A1			S-4	2.5				
A2			II	1.0				
B1			S-3	2.5				
B2			S-3	2.5				

IL = inspection level
AQL = acceptable quality level

TABLE III B

Inspection sub-group**	D*			E			F*			G*		
	p	n	c	p	n	c	p	n	c	p	n	c
C1A				6	9	1						
C1B				6	18	1						
C1				6	27	1						
C2				6	9	1						
C3				3	24	1						
C4A				12	6	1 } 1						
C4B				12	6	1						
C5				6	15	1						

p = periodicity in months
n = sample size
c = permitted number of defectives

Notes concerning Tables III A and III B:

* The assessment levels D, F and G are under consideration.

** The content of the Inspection sub-groups is described in Section Two of the relevant blank detail specification.

SECTION FOUR — TEST AND MEASUREMENT PROCEDURES

This section supplements the information given in IEC Publication 384-1, Section Four.

4. Test and measurement procedures

4.1 *Visual inspection and check of dimensions*

IEC Publication 384-1, Sub-clause 4.4.

4.2 *Electrical tests*

4.2.1 *Leakage current*

See Sub-clause 4.9 of IEC Publication 384-1, with the following details:

4.2.1.1 *Measuring conditions*

The rated voltage shall be applied across the capacitor and its protective resistor.

The protective resistor shall be between 1 000 Ω and 10 000 Ω.

In the case of bipolar capacitors, the duration of the electrification periods before the measurement made in each direction is 5 min.

4.2.1.2 *Requirement*

The leakage current at 20 °C, 85 °C and 125 °C shall not exceed the limits specified in the detail specification; the value of these limits shall be equal to or greater than 1 µA, 10 µA and 12.5 µA respectively.

4.2.2 *Capacitance*

Sub-clause 4.7 of IEC Publication 384-1, with the following details:

4.2.2.1 *Measuring conditions*

The capacitance shall be measured at a frequency of 100 Hz or 120 Hz. The peak alternating voltage actually applied across the capacitor shall be between 0.1 V and 1.0 V.

A d.c. bias voltage of 2.1 V to 2.5 V may be applied during the measurement (unless otherwise prescribed in the detail specification), except for bi-polar capacitors which shall be measured without an applied d.c. voltage.

Suitable measurement techniques shall be used to minimize errors due to connections between the measuring apparatus and the capacitors.

4.2.2.2 *Requirement*

The capacitance shall be within the specified tolerance.

4.2.3 *Tangent of loss angle (tan δ)*

Sub-clause 4.8 of IEC Publication 384-1, with the following details:

4.2.3.1 *Measuring conditions*

The measurement shall be made under the conditions of Sub-clause 4.2.2.

4.2.3.2 *Requirement*

The tangent of loss angle shall not exceed the limits specified in the detail specification.

4.2.4 *Impedance*

Sub-clause 4.10 of IEC Publication 384-1, with the following details:

4.2.4.1 *Initial measurement*

The frequency of the measuring voltage shall be chosen from one of the following frequencies: 100 Hz, 120 Hz, 1 kHz, 10 kHz, 100 kHz and 1 MHz, and shall be that at which the lowest value of impedance is likely to occur.

The tolerance on all frequencies for measuring purposes shall not exceed ±20%.

The value of the measuring frequency shall be prescribed in the detail specification.

4.2.4.2 *Measuring conditions*

When required in the detail specification, the impedance shall be determined at the required temperature and frequency. If the peak a.c. voltage exceeds 0.5 V on polar types, a direct polarizing voltage of 2.1 V to 2.5 V may be applied.

The application of voltage shall be such as to cause no readable change in impedance due to the change in the temperature of the capacitor.

The error of measurement shall not exceed ±5% of the requirement, or 0.1 Ω, whichever is the greater.

Note. — It should be remembered that great care should be exercised in making these measurements when the impedance values are low.

4.2.4.3 *Measurement at lower category temperature*

The frequency shall be 100 Hz or 120 Hz unless otherwise specified in the detail specification.

4.2.4.4 *Requirement*

The impedance shall meet the requirements of the detail specification.

4.2.5 *Insulation resistance of the external insulation* (if applicable)

Sub-clause 4.5 of IEC Publication 384-1, with the following details:

4.2.5.1 *Measuring conditions*

A metal foil shall be wrapped closely around the full length of the body of the capacitor, protruding by at least 5 mm from each end, provided a minimum space of 1 mm can be maintained between the metal foil and the terminations. The ends of the foil shall not be folded over the ends of the capacitor. If the 1 mm space cannot be maintained, the protrusion of the foil shall be reduced as may be necessary to establish the 1 mm space.

When applicable, the V-block method is permitted as an alternative.

A direct voltage of 100 ± 15 V shall be applied between the metal foil or the V-block and the termination connected to the capacitor body for a minimum of 1 min or for the time required to obtain a stable reading. At the end of this period the insulation resistance shall be measured.

4.2.5.2 *Requirement*

The insulation resistance shall be not less than 100 MΩ.

4.2.6 *Voltage proof of the external insulation* (if applicable)

Sub-clause 4.6 of IEC Publication 384-1, with the following details:

4.2.6.1 *Measuring conditions*

A metal foil shall be wrapped closely around the body of the capacitor, protruding by at least 5 mm from each end, provided a minimum space of 1 mm can be maintained between the metal foil and the terminations. The ends of the foil shall not be folded over the ends of the capacitor. If the 1 mm space cannot be maintained, the protrusion of the foil shall be reduced as may be necessary to establish the 1 mm space.

When applicable, the V-block method is permitted as an alternative.

A direct voltage gradually increasing at a rate of 100 V/s to a maximum of 1 000 V shall be applied between the metal foil or the V-block and the termination connected to the capacitor body.

The voltage of 1 000 V shall be applied for 1 min ± 5 s.

4.2.6.2 *Requirement*

There shall be no breakdown or flashover during the test.

4.3 *Robustness of terminations*

Sub-clause 4.13 of IEC Publication 384-1, with the following details:

4.3.1 *Initial measurement*

The capacitance shall be measured according to Sub-clause 4.2.2.

4.3.2 *Test Ud — Not applicable*

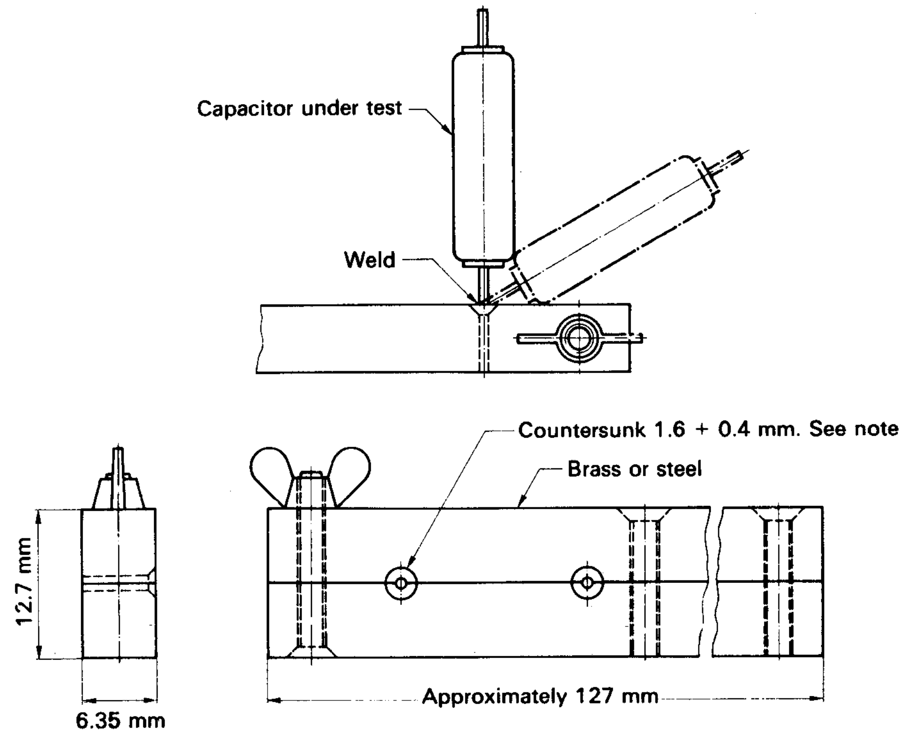
However, capacitors with external welds on wire leads shall be subjected only to the procedure of Test Ua_1 and to the bending test described in Sub-clause 4.3.3 when prescribed by the detail specification.

4.3.3 *Special bending test*

4.3.3.1 *Purpose*

To determine the ability of the termination to withstand the bending likely to be applied during normal assembly operation.

4.3.3.2 *Apparatus* (see Figure 1)



Note. — The diameter of the hole shall be 0.025 mm less than the diameter of the termination.

FIGURE 1

4.3.3.3 *Test procedure*

The termination shall be inserted into the hole in the fixture (Figure 1) so that the lower side of the weld on the soldered joint is approximately flush with the surface of the fixture. The case shall be forced over in such a manner that the tantalum stub is maintained in its axial position as closely as possible while bending the termination until the end of the case just touches the top surface of the fixture.

When the case is returned to its normal position, one bend will have been completed.

Succeeding bends shall be made in alternate directions.

4.3.3.4 *Requirements*

The terminations shall withstand four successive bends.

4.4 *Resistance to soldering heat*

Sub-clause 4.14 of IEC Publication 384-1, with the following details:

4.4.1 *Conditions:* No pre-drying

4.4.2 *Final inspection, measurements and requirements*

The capacitors shall be visually examined and measured and shall meet the requirements given in Table II.

4.5 *Solderability*

Sub-clause 4.15 of IEC Publication 384-1, with the following details:

4.5.1 *Test conditions:* No ageing

The requirements for the globule test method shall be prescribed in the detail specification. Where neither the solder bath nor the solder globule method is appropriate the soldering-iron test shall be used with soldering iron size A.

4.5.2 The performance requirements are given in Table II.

4.6 *Rapid change of temperature*

Sub-clause 4.16 of IEC Publication 384-1, with the following details:

4.6.1 *Initial measurement*

The capacitance shall be measured according to Sub-clause 4.2.2.

4.6.2 *Test conditions*

The capacitors shall be subjected to Test Na for five cycles. The duration of the exposure at each temperature limit shall be 30 min.

The recovery period shall be max. 16 h.

4.6.3 *Final measurements and requirements*

After recovery the capacitors shall be measured and shall meet the requirements shown in Table II.

4.7 *Vibration*

Sub-clause 4.17 of IEC Publication 384-1, with the following details:

4.7.1 Procedure B4 of Test Fc shall be applied with one of the following severities as prescribed by the detail specification:

Frequency (Hz)	Amplitude or acceleration (whichever is the lower acceleration)	Duration (hours)
10-55	0.35 mm or 49 m/s² (5 *g*)	3 × 0.5
10-55	0.75 mm or 98 m/s² (10 *g*)	3 × 2
10-500	0.75 mm or 98 m/s² (10 *g*)	3 × 2
10-2 000	0.75 mm or 98 m/s² (10 *g*)	3 × 2

The detail specification shall specify the frequency range and shall also prescribe the mounting method to be used. For capacitors with axial leads and intended to be mounted by the leads only, the distance between the body and the mounting point shall be 6 ± 1 mm.

4.7.2 *Final inspection, measurements and requirements*

The capacitors shall be visually examined and measured and shall meet the requirements given in Table II.

4.8 *Bump*

Sub-clause 4.18 of IEC Publication 384-1, with the following details:

The detail specification shall state whether the bump or the shock test applies.

4.8.1 Total number of bumps: 1 000 for general-purpose grade capacitors
4 000 for long-life grade capacitors

The detail specification shall also prescribe the mounting method to be used. For capacitors with axial leads and intended to be mounted by the leads only, the distance between the body and the mounting point shall be 6 ± 1 mm.

4.8.2 *Final inspection, measurements and requirements*

The capacitors shall be visually examined and measured and shall meet the requirements given in Table II.

4.9 *Shock*

Sub-clause 4.19 of IEC Publication 384-1, with the following details:

The detail specification shall state whether the shock or the bump test applies.

4.9.1 The detail specification shall state which of the following preferred severities applies:

Pulse shape: half-sine

Peak acceleration (m/s² (g))	Corresponding duration of the pulse (ms)
294 (30)	18
490 (50)	11
981 (100)	6

The detail specification shall also prescribe the mounting method to be used. For capacitors with axial leads and intended to be mounted by the leads only, the distance between the body and the mounting point shall be 6 ± 1 mm.

4.9.2 *Final inspection, measurements and requirements*

The capacitors shall be visually examined and measured and shall meet the requirements given in Table II.

4.10 *Climatic sequence*

Sub-clause 4.21 of IEC Publication 384-1, with the following details:

4.10.1 *Initial measurement*

The capacitance shall be measured according to Sub-clause 4.2.2.

4.10.2 *Dry heat*

Sub-clause 4.21.2 of IEC Publication 384-1.

4.10.3 *Damp heat, cyclic, Test Db, first cycle*

Sub-clause 4.21.3 of IEC Publication 384-1.

4.10.4 *Cold*

Sub-clause 4.21.4 of IEC Publication 384-1.

4.10.5 *Low air pressure* (if required by the detail specification)

Sub-clause 4.21.5 of IEC Publication 384-1, with the following details:

4.10.5.1 The test, if required in the detail specification, shall be made at a temperature of 15 °C to 35 °C and an air pressure of 8.5 kPa (85 mbar).

The duration of the test shall be 5 min.

4.10.5.2 During the last minute of the test, the rated voltage (U_R) shall be applied.

4.10.5.3 *Requirements*

During and after the test, the capacitor shall meet the requirements shown in Table II.

4.10.6 *Damp heat, cyclic, Test Db, remaining cycles*

Sub-clause 4.21.6 of IEC Publication 384-1.

4.10.7 *Sealing* (if required by the detail specification)

Sub-clause 4.20 of IEC Publication 384-1, with the following details:

The test shall be applied at the end of the climatic sequence.

4.10.7.1 The detail specification shall prescribe which test or method applies.

4.10.7.2 *Recovery*

If the capacitors have been immersed in a liquid, they shall be shaken to remove excess liquid, and then remain under standard atmospheric conditions for testing for 1 to 2 h.

4.10.8 *Final inspection, measurements and requirements*

The capacitors shall be visually examined and measured and shall meet the requirements shown in Table II.

4.11 *Damp heat, steady state*

Sub-clause 4.22 of IEC Publication 384-1, with the following details:

4.11.1 *Initial measurement*

The capacitance shall be measured according to Sub-clause 4.2.2.

4.11.2 *Final inspection, measurements and requirements*

After recovery, the capacitors shall be inspected and measured and shall meet the requirements shown in Table II.

4.12 *Endurance*

Sub-clause 4.23 of IEC Publication 384-1, with the following details:

4.12.1 *Initial measurement*

The capacitance shall be measured according to Sub-clause 4.2.2.

4.12.2 Duration:	2 000 h for long-life grade capacitors; 1 000 h for general-purpose grade capacitors.
Ambient temperature:	upper category temperature.
Applied voltage:	category voltage, unless otherwise specified in the detail specification.

Note. — When the category voltage and/or temperatures are different from the rated voltage and/or temperatures, the sample tested is divided into two parts and submitted to the rated and category voltages and temperatures respectively.

During the test of bipolar capacitors, the applied voltage shall be reversed in polarity at intervals of 168 ± 24 h.

When specified in the detail specification a sinusoidal alternating voltage with frequency of 50 Hz, 60 Hz, 100 Hz or 120 Hz, as specified, may be superimposed on the d.c. voltage provided that the peak voltage does not exceed the value of the rated direct voltage and that the rated ripple current is not exceeded.

a) For solid electrolyte capacitors only, the test voltage shall be applied gradually (not less than 2 min but not more than 5 min) either by a slow build-up of voltage or through a resistor which shall be shorted out within 5 min. The impedance of the voltage source shall be 0.1 Ω/V minimum with a maximum of 3 Ω.

b) For non-solid electrolyte capacitors the test voltage shall be supplied by a regulated power-supply free from surges, having a low internal resistance, and shall be applied to each capacitor or capacitor section through a separate resistor. The value of this resistor shall be so chosen that a short-circuit of one of the capacitors or capacitor sections will have no influence on the rest of the sample, but the resistance value shall not exceed 1 000 Ω.

4.12.3 *Final inspection, measurements and requirements*

After recovery for minimal 16 h, the capacitors shall be visually examined and measured and shall meet the requirements shown in Table II.

4.13 *Surge*

Sub-clause 4.26 of IEC Publication 384-1, with the following details:

4.13.1 *Initial measurement*

The capacitance shall be measured according to Sub-clause 4.2.2.

4.13.2 *Test procedure*

The capacitors shall be subjected to 1 000 cycles each consisting of a charge as described below, followed by a no-load period of 5 min 30 s.

A voltage, equal to the surge voltage, shall be applied during 30 s through a resistor with a value so that the total resistance in series with the capacitor and voltage source is 1 000 ± 100 Ω.

The test shall be made at the following temperatures:

Upper category temperature	Test temperature
≤85 °C	All specimens at upper category temperature
>85 °C	50% of the specimens at 85 °C and the remaining 50% at the upper category temperature

Each surge voltage cycle shall be performed in such a manner that the capacitor is discharged through the resistor of approximately 1 000 Ω at the end of the 30 s application.

The test shall be terminated on the discharge portion of the cycle. For bi-polar capacitors, the polarity shall be reversed after 500 cycles.

4.13.3 *Final inspection, measurements and requirements*

After recovery, the capacitors shall be visually examined and measured and shall meet the requirements given in Table II.

4.14 *Reverse voltage* (if required by the detail specification)

4.14.1 *Initial measurement*

The capacitance shall be measured according to Sub-clause 4.2.2.

4.14.2 The capacitors shall be subjected to the conditions under *a)* followed by the conditions under *b)*:

a)	Test temperature:	upper category temperature.
	Applied voltage:	3 V d.c. or 10% of the rated voltage, whichever is the less, in the reverse polarity direction, unless otherwise specified in the detail specification.
	Duration:	125 h.
b)	Test temperature:	upper category temperature.
	Applied voltage:	direct voltage equal to the category voltage in the forward polarity direction.
	Duration:	125 h.

4.14.3 *Final measurements and requirements*

After recovery the capacitors shall be visually examined and measured and shall meet the requirements given in Table II.

4.15 *Characteristics at high and low temperature*

Sub-clause 4.29 of IEC Publication 384-1, with the following details:

4.15.1 *Measurements and requirements*

The capacitors shall be measured and shall meet the requirements shown in Table II.

4.16 *Charge and discharge* (if required by the detail specification)

Sub-clause 4.27 of IEC Publication 384-1, with the following details:

4.16.1 *Initial measurement*

The capacitance shall be measured according to Sub-clause 4.2.2.

4.16.2 At an ambient temperature of 20 °C, unless otherwise specified in the detail specification, the capacitors shall be subjected to the specified number of cycles, each cycle consisting of a charge according to *a)*, followed by a discharge according to *b)*.

In cases where an increase of the cycling period is required, leaving the charging time unchanged in order not to exceed the maximum permissible heat generated in the capacitor, this shall be stated in the detail specification.

a) Charge
Applied voltage: rated direct voltage
Internal resistance of the voltage source plus external series resistor: see detail specification
Duration: 0.5 s

b) Discharge
No voltage applied
Discharge resistor: see detail specification
Duration: 0.5 s

Number of cycles: 10^6
Recovery: 24 h

4.16.3 *Final inspection, measurements and requirements*

The capacitors shall be visually examined and measured and shall meet the requirements shown in Table II.

AMENDMENT NO. 1

Page 6

Sub-clause 2.2.5

Replace the existing text by the following:

2.2.5 *Reverse voltage*

2.2.5.1 *Rated reverse voltage*

The value of reverse voltage which a polar capacitor can withstand continuously at any temperature between the lower category temperature and the rated temperature (to be specified in the detail specification).

2.2.5.2 *Test reverse voltage*

The value of the voltage used for the purpose of carrying out the reverse voltage test.

Page 8

Table I

Add the following tests:

— Group 1A

Add the following test after Resistance to soldering heat:

4.17 Component solvent resistance

— Group 1B

Add the following test after Solderability:

4.18 Solvent resistance of the marking

Page 9

Table II

Add the following test in Group 1A, after Resistance to soldering heat:

4.17 Component solvent resistance (if applicable)		Solvent: ... Solvent temperature: ... Method 2 Recovery time: ...		See detail specification

Add the following test in Group 1B, after Solderability:

4.18 Solvent resistance of the marking (if applicable)		Solvent: ... Solvent temperature: ... Method 1 Rubbing material: ... Recovery time: ...		Legible marking

Page 13

Table II

Group 4B, Sub-clause 4.14, replace under "Conditions of test" in two places upper category temperature *by* rated temperature.

Note. — As a consequence the same change applies to the conditions of test specified in the Sub-group C4B for the reverse voltage test in the related Blank Detail Specifications, IEC Publications 384-15-1, 384-15-2 and 384-15-3.

Page 26

Sub-clause 4.14

Replace the existing text by the following:

4.14 *Reverse voltage* (if required by the detail specification)

4.14.1 *Initial measurement*

Initial measurements shall be made as prescribed by Sub-clause 4.3.1.

4.14.2 The capacitors shall be subjected to the test as follows:

a) Sub-family 1 (non-solid electrolyte capacitors with foil electrode).

Test temperature: rated temperature.

Test reverse voltage: 3 V d.c. (unless otherwise specified in the detail specification) applied to each capacitor through a resistor of 1 000 ± 100 Ω.

Test duration: 125 h in the reverse polarity direction with the test reverse voltage followed by 125 h in the forward polarity direction with the rated voltage.

b) Sub-family 2 (non-solid electrolyte capacitors with porous anode).

If applicable, the same conditions as specified for Sub-family 1 apply.

c) Sub-family 3 (solid electrolyte capacitors with porous anode).

Test temperature: rated temperature.

Test reverse voltage: 0.1 × rated voltage, but with max. 3 V d.c. (unless otherwise specified in the detail specification).

The voltage applied to each capacitor shall be from a voltage source with a minimum impedance of 0.1 Ω/V with a maximum of 3 Ω. (The voltage shall be applied gradually as described in Sub-clause 4.12.2 *a)*.

Test duration: 125 h in the reverse polarity direction with test reverse voltage followed by 125 h in the forward polarity direction with the rated voltage.

4.14.3 *Final measurements and requirements*

After recovery the capacitors shall be visually examined and measured and shall meet the requirements given in Table II.

Page 27

Add the following sub-clauses:

4.17 *Component solvent resistance*

Sub-clause 4.31 of IEC Publication 384-1.

4.18 *Solvent resistance of the marking*

Sub-clause 4.32 of IEC Publication 384-1.

AMENDMENT NO. 2

Page 8

Sub-clause 3.4.2, Table I

- Group 0. In columns 2 and 3 respectively, above "Visual examination" and "4.1" add "High surge current 5)" and "4.17".
- Add a footnote 5) as follows: "For solid electrolyte capacitors only and if prescribed by the detail specification."

Page 9

Sub-clause 3.4.2, Table II

Amend the following test groups as indicated:

- Group 0. In the first column, above "4.1 Visual examination" add: "4.17 High surge current*".
- Add a footnote at the bottom of the page as follows:

  "* For solid electrolyte capacitors only and if prescribed by the detail specification."

Page 11 Table II (continued)

- Group 1, Sub-clause 4.10.7

  1) Transfer this sub-clause to the end of the group after 4.10.8
  2) Add as Performance requirement: "Maximum leakage: ..."
  3) Renumber the present sub-clause

     "4.10.7" to "4.10.8" and
     "4.10.8" to "4.10.7"

Page 12 Table II (continued)

- Group 2, Performance requirements

  Change for Long-life grade capacitors the capacitance change $\frac{\Delta C}{C}$ from "$\leq$ 5 %" to "$\leq$ 8 %".

Page 14 Table II (continued)

- Group 5, Sub-clause 4.15

  1) Insert between Steps 2 and 3 new Step 3 as follows:

     Step 3: 20 °C (if applicable)

  2) Renumber the present Steps 3 and 4 to Steps 4 and 5

  3) Add a new Step 6: 20 °C (if applicable)

  4) Add for the new Steps 3 and 6 the conditions of test

     - Leakage current
     - Capacitance
     - Tangent of loss angle
     - Impedance (if applicable)

  5) The applicability of the Steps 3 and 6 shall be given in the detail specification.

- Group 5, Sub-clause 4.16.3

  Add after Visual examination in:

3rd column:	5th column:
"Leakage current"	"$\leq$ initial limit"

Page 16

- Sub-clause 3.5.3

  Replace "capacitance" in the second sentence by:

  "... for Sub-families 1 and 2: leakage current and for Sub-family 3: capacitance."

- Table IIIA

  - In column 1, above "A1" insert "A0***".

  - On the same line in column 4 insert: "100 %".

- At the bottom of the page add a footnote as follows:

  "*** High surge current test, for solid electrolyte capacitors only and if required by the detail specification."

Page 17

Sub-clause 4.2.1.1

Replace in first sentence: "the rated voltage" by "the voltage appropriate to the test temperature".

Sub-clause 4.2.1.2

Delete the second part of the sentence:

> "the value of these ..... 12,5 μA respectively".

Page 20

Sub-clause 4.3.2

Replace title by: "Tests U_{a1}, U_b and U_c applicable".

Page 22

Sub-clause 4.7.1

Replace in first line after the table:

> "frequency range" by "severity (frequency/amplitude or acceleration/duration)".

Page 24

Sub-clause 4.10.7

Renumber this sub-clause to "4.10.8"

Sub-clause 4.10.8

- Renumber this sub-clause to "4.10.7"

- Replace the text by:

> "The capacitors shall be kept under standard atmospheric conditions for testing for 1 to 2 h and shall then be inspected and measured and meet the requirements shown in Table II."

Page 25

Sub-clause 4.12.2 a)

Change the last sentence to read:

> "The impedance seen from the terminals of each capacitor shall not exceed 3 Ω."

Page 27

Add a new clause 4.19 as follows:

4.19 High surge current (for solid electrolyte capacitors only and if required by the detail specification)

See 4.39 of IEC Publication 384-1 with the following details:

4.19.1 Initial measurements

Not required.

4.19.2 Measurements and requirements

Final measurements and requirements are those for the subsequent tests in Group 0 or in the blank detail specification or Group A, as appropriate.

(*Continued from second cover*)

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC QC 001002 (1986) Rules of procedure of the IEC quality assessment system for electronic components (IECQ)	IS QC 001002 : 1988/ IEC QC 001002 :1986 Rules of procedure of the IEC quality assessment system for electronic components (IECQ)	Identical
ISO 3 Preferred numbers — Series of preferred numbers	IS 1076 (Part 1) : 1985 Preferred numbers : Part 1 Series of preferred numbers	do

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